The art and science of amateur experimentalism

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» Energetic Materials

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Author: **Subject: Copper Thermite**

Agari
Banned

posted on 11-11-2015 at 15:54

Copper Thermite

Posts: 160
Registered: 8-10-2015
Location: The Amine Group
Member Is Offline

Mood: Lowest Oxidation State

Is there any way to obtain a reasonable amount of copper from a copper thermite reaction? In another thread in Beginnings titled "Quest for the elements", J_sum mentioned that it might be possible to add a slag material to stabilize the otherwise explosive reaction and possibly obtain a reasonable amount of copper for an element collector. What material should I use?Is there anything else I need to know when trying to obtain copper from a Cu2O or CuO thermite reaction?

Element Collection Status:
Elements Acquired: 21/91
Latest: Lead (Pb)
Quantity: 12g

PROFILE FIND

j_sum1
Administrator

posted on 11-11-2015 at 16:29

Posts: 4942
Registered: 4-10-2014
Location: Oz
Member Is Offline

Mood: Metastable, and that's good enough.

I don't know the exact answer. But I can tell you some of the things to watch out for.

Firstly, you want to know the amount of energy given off in your reaction Heats of formation will get you there.

Secondly you want to know what temperature and phases your reaction products will be in. You need data on the heat capacities of the various products and also the latent heat of fusion and latent heat of vaporisation as appropriate. See what temperature your reaction gets to when all the heat given off goes into heating up the products -- which is not a bad first approximation. A bit of maths here will give you the phases of all your reactants.

Thirdly you want to think about the densities and other physical properties of your products. For metal recovery, you want a liquid metal denser than your slag so that it sinks to the bottom. You would like the metal to be sufficiently above its melting temperature so that it coalesces into one lump. You also want a liquid slag that is very fluid and covers your metal well. Good wetting properties I guess. With that in mind you want enough liquid slag to form an effective cover.

So an effective slag addition will (a) absorb some energy and help to control the temperature, (b) add to the volume of the slag (c) form a nice eutectic with the product of your reaction (typically Al2O3) so that the slag is very fluid. (d) acts as a diluent to slow the rate f reaction which allows the excess heat to disperse a bit and allows your reaction products yo move in a more controlled fashion.

Other alterations are to add a helper reaction to raise the temperature a bit. Al/S is common here but there are other options. I don't think you want to do this for copper.

And, no. I have not done a whole lot of this. I have mostly followed recipes in my thermites.

Blogfast will be here soon to correct some of what I have stated. This really is an engineering problem. It is well and good to talk about the process in broad general principles. It is quite another thing to know the specifics of what works well and what doesn't. I will say this though -- avoid hydrated salts of any kind in your slag. The steam given off will blow your reaction all over the place.

PROFILE FIND

Oscilllator
International Hazard
posted on 11-11-2015 at 19:08

Posts: 659
Registered: 8-10-2012
Location: The aqueous layer
Member Is Offline

Mood: No Mood

One thing j_sum1 didn't mention is particle size. If you use coarse aluminium powder that will slow down the reaction rate. Perhaps in this case because the reaction is so vigorous you may want to try using chopped up aluminium foil.

You should also compact the mixture before you ignite it. I've found that fluffy thermites tend to burn faster and be more spectacular, but this is not what you want here.

PROFILE FIND

Amos
International Hazard
posted on 11-11-2015 at 19:16

Posts: 1221
Registered: 25-3-2014
Location: Yes
Member Is Offline

Mood: No

If you want to obtain some copper via another route, there are two very easy routes through aqueous chemistry.

PROFILE FIND

careysub
International Hazard
posted on 11-11-2015 at 19:44

Posts: 1339
Registered: 4-8-2014
Location: Coastal Sage Scrub Biome
Member Is Offline

Mood: Lowest quantum state

Not sure what your objective is here, and thus what the relevant parameters are. Highly pure copper is readily available (electrical wire), and a 5% zinc alloy is just a few dollars a pound (pre 1982 pennies).

It is just that you want to melt copper down into a lump?

You definitely want the lower oxygen content, and thus less energetic, red copper oxide (Cu2O).

Coarse aluminum slows down the reaction, thus presumably letting more heat escapes from a slower reaction.

You can use a cheap flux mixture of salt and potassium chloride (or just use Lite Salt, but it is crazy overpriced):
http://www.google.com/patents/US4038068

Enough salt should soak up the heat to prevent volatilization.

You could also add metallic copper to the mix. Copper powder would be best, but clipping copper wire into little bits with a wire cutting plier might work pretty well.

PROFILE FIND

Agari
Banned
posted on 11-11-2015 at 19:48

Posts: 160
Registered: 8-10-2015
Location: The Amine Group
Member Is Offline

> **Quote: Originally posted by careysub**
>
> Not sure what your objective is here, and thus what the relevant parameters are. Highly pure copper is readily available (electrical wire), and a 5% zinc alloy is just a few dollars a pound (pre 1982 pennies).

Mood: Lowest Oxidation State

It is just that you want to melt copper down into a lump?

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Enough salt should soak up the heat to prevent volatilization.

You could also add metallic copper to the mix. Copper powder would be best, but clipping copper wire into little bits with a wire cutting plier might work pretty well.

I am on a "quest" to collect 91 elements, pure as possible. I have obtained 16 so far. The thing is,I, like another poster in the Beginnings forum, want to extract said elements from compounds containing them,rather than buying them. Right now,I want to obtain copper.
Edit:Instead of electrolysis of copper sulfate,I decided to do a copper thermite reaction, I just need advice on how to recover the copper produced from copper oxide burning.

[Edited on 12-11-2015 by Agari]

Element Collection Status:
Elements Acquired: 21/91
Latest: Lead (Pb)
Quantity: 12g

PROFILE FIND

DraconicAcid
International Hazard
★★★★★

posted on 11-11-2015 at 19:58

Posts: 3183
Registered: 1-2-2013
Location: The tiniest college campus ever....
Member Is Offline

Mood: Semi-victorious.

You'd be better off dissolving it in hydrochloric acid and reducing it with aluminum or another active metal. Thermites get messy.

Please remember: "Filtrate" is not a verb.
Write up your lab reports the way your instructor wants them, not the way your ex-instructor wants them.

PROFILE FIND

j_sum1
Administrator
★★★★★★★★

posted on 11-11-2015 at 20:07

Posts: 4942
Registered: 4-10-2014
Location: Oz
Member Is Offline

Mood: Metastable, and that's good enough.

Let me give you the heads up -- you aren't going to get all 91. And of those you will end up buying a substantial number. See "the trials and tribulations of thorium production" thread for details.

My goals are similar. But I decided early on that I would have multiple samples of many elements and include both samples that I had extracted and purer purchased samples. I figured that each sample tells its own story and often one story is not nearly enough for the element. So, for carbon I have large graphite blocks, activated charcoal, graphite from an electric motor, battery electrodes, natural diamonds and synthetic diamonds. I haven't really prepared my copper specimens yet but there are likely to be a few there. I was looking at some native copper on ebay yesterday.

Thus far I have more than 40 elements and probably about 80 samples. I really should do an

up-to-date count. I've been going for a year.

So, good luck. If you can do a successful copper thermite, it will tell a good story. And I will pinch your recipe.

PROFILE FIND

Agari
Banned

posted on 11-11-2015 at 20:42

Posts: 160
Registered: 8-10-2015
Location: The Amine Group
Member Is Offline

Mood: Lowest Oxidation State

> **Quote:** **Originally posted by j_sum1**
>
> Let me give you the heads up -- you aren't going to get all 91. And of those you will end up buying a substantial number. See "the trials and tribulations of thorium production" thread for details.
>
> My goals are similar. But I decided early on that I would have multiple samples of many elements and include both samples that I had extracted and purer purchased samples. I figured that each sample tells its own story and often one story is not nearly enough for the element. So, for carbon I have large graphite blocks, activated charcoal, graphite from an electric motor, battery electrodes, natural diamonds and synthetic diamonds. I haven't really prepared my copper specimens yet but there are likely to be a few there. I was looking at some native copper on ebay yesterday.
>
> Thus far I have more than 40 elements and probably about 80 samples. I really should do an up-to-date count. I've been going for a year.
>
> So, good luck. If you can do a successful copper thermite, it will tell a good story. And I will pinch your recipe.

I may or may not collect them in order. For instance,I might buy a piece of uranium metal (Or a uranium mineral sample) instead of thorium,assuming that the company that runs minresco.com is still selling. But you are right,I may end up buying a huge amount of them. Yes,I am fully aware that almost all elements after 91 are radioactive and some such as Francium are also radioactive,unobtainable,or both. The idea of having to reach a certain amount of elements is simply more encouraging to me.
On a sidenote, what would a good thermal absorber(Slag material) be to cool off the thermite reaction?
Edit again: My idea,thanks to the help of the above posters, is to have a relatively small containment vessel that could withstand the reaction, use low-grade copper(I)oxide thermite by using clumped and coarse powder with possibly adding a material with a high melting point,possibly use one material in excess so that some of the fuel doesn't react,and to use small amounts of thermite in small batches to retrieve the copper. Is there any way to improve this yet-hypothetical experiment?

[Edited on 12-11-2015 by Agari]

[Edited on 12-11-2015 by Agari]

Element Collection Status:
Elements Acquired: 21/91
Latest: Lead (Pb)
Quantity: 12g

PROFILE FIND

j_sum1
Administrator
★★★★★★★★

posted on 11-11-2015 at 20:57

Posts: 4942
Registered: 4-10-

Amos suggested copper but that goes against the spirit of the thing.
Careysub suggested NaCl and KCl. I said CaF2 or possibly CaO.
But, like I said, I have little actual experience here. If you have the reagents, it sounds like a

2014
Location: Oz
Member Is Offline

Mood: Metastable, and that's good enough.

classic investigation is in order. Do some research and some calculations. Adjust a few variables. Collect results. Tell us all how it turned out.

PROFILE FIND

Agari
Banned

posted on 11-11-2015 at 22:53

Posts: 160
Registered: 8-10-2015
Location: The Amine Group
Member Is Offline

Mood: Lowest Oxidation State

> **Quote: Originally posted by j_sum1**
>
> Amos suggested copper but that goes against the spirit of the thing. Careysub suggested NaCl and KCl. I said CaF2 or possibly CaO. But, like I said, I have little actual experience here. If you have the reagents, it sounds like a classic investigation is in order. Do some research and some calculations. Adjust a few variables. Collect results. Tell us all how it turned out.

This post will keep track of my progress on just that. I read the "Exotic Thermites and Analogs" thread by Polverone (Sticky under Energetic Materials), and he described a thermite experiment using copper(II) chloride and aluminum initiated by an alcohol burner which resulted in solid copper being deposited,while a combination of CuCl2 and 300 mesh aluminum powder burned quickly. If a copper oxide thermite reaction doesn't produce a decent amount of copper, then I might try copper chloride and aluminum.
Edit: My idea,thanks to the help of the above posters, is to have a relatively small containment vessel that could withstand the reaction, use low-grade copper(I)oxide thermite by using clumped and coarse powder with possibly adding a material with a high melting point,possibly use one material in excess so that some of the fuel doesn't react,and to use small amounts of thermite in small batches to retrieve the copper.

[Edited on 12-11-2015 by Agari]

Element Collection Status:
Elements Acquired: 21/91
Latest: Lead (Pb)
Quantity: 12g

PROFILE FIND

j_sum1
Administrator
★★★★★★★★

posted on 11-11-2015 at 23:10

Posts: 4942
Registered: 4-10-2014
Location: Oz
Member Is Offline

Mood: Metastable, and that's good enough.

Sounds good. Check the matter of hydration. Steam will make things messy usually.

PROFILE FIND

Amos
International Hazard
★★★★★

posted on 12-11-2015 at 05:40

Posts: 1221
Registered: 25-3-2014

If you get tired of trying this method, you can dissolve some copper(II) oxide in sulfuric acid to get copper sulfate or just use copper sulfate you purchased in this manner:

Location: Yes
Member Is Offline

Mood: No

Get a saturated solution copper(II) sulfate up to boiling and add some ascorbic acid. It will reduce the copper in solution to a fine powder of elemental copper and lead to the formation of a soluble yellow complex in addition.

One more route would be to treat fine steel wool with a molar excess of copper(II) sulfate and briefly boiling(this breaks up the precipitating copper and helps it fall to the bottom) to yield pure copper metal. A bonus of this method is that once the copper metal has been filtered out, you can add more steel wool to the filtrate to remove all remaining copper and be left with a pretty pure solution of iron(II) sulfate that can be boiled down and crystallized to yield a useful reagent.

PROFILE FIND

Theldeanator
Harmless

posted on 12-11-2015 at 16:04

Posts: 29
Registered: 8-11-2015
Member Is Offline

Mood: No Mood

It's much safer and easier to produce high purity copper through electrochemistry. Buy some sodium sulfate stump killer and run it through a bunch of different acids and bases to separate copper from everything else and then plate it out and collect the growth.

If you insist on thermite, the best way to maximize yield is with a larger volume of reactants. Cover the thermite and fill the collection pit with a very fine high temperature flux such as boric acid, sand, fluorite, etc. Sand might be best since you can soak it in HF to dissolve that afterwards.

PROFILE FIND

j_sum1
Administrator

posted on 12-11-2015 at 16:09

Posts: 4942
Registered: 4-10-2014
Location: Oz
Member Is Offline

Mood: Metastable, and that's good enough.

If you don't mind playing with HF, that is.

I agree there are much easier ways of getting copper than via thermite. But, this is a challenge. It could be fun.

PROFILE FIND

MolecularWorld
Hazard to Others

posted on 12-11-2015 at 16:37

Posts: 110
Registered: 30-10-2015
Member Is Offline

Mood: No Mood

I attempted a thermite with anhydrous copper (II) sulfate, 30um aluminum, and a little sodium sulfate as flux. It was very difficult to ignite. The exact ratio of reactants is unknown; I started with 10g Al, 10g Na_2SO_4, & 80g $CuSO_4$, but such a mixture wouldn't ignite (it did react to give copper-colored slag when heated with a blowtorch), so I added some more aluminum. I was eventually able to ignite this; it was slower than CuO thermite, but faster than iron oxide thermites. Unfortunately, there wasn't enough heat or flux to produce nice copper globules, but most of the copper was recoverable as particles mixed in with the slag.

It looks more coppery in person; I'd estimate this crap is around half copper, and looks somewhat similar to some native copper I've seen. The image shows the slag after washing in water. The mixture was ignited atop a bed of bentonite granules (cat litter), the blackened remnants of which form most of the rest of the slag. One downside to using sulfates is that the

slag did smell slightly of hydrogen sulfide when added to water.

[Edited on 13-11-2015 by MolecularWorld]

PROFILE FIND

Agari
Banned

posted on 12-11-2015 at 17:17

Posts: 160
Registered: 8-10-2015
Location: The Amine Group
Member Is Offline

Mood: Lowest Oxidation State

> **Quote: Originally posted by MolecularWorld**
>
> I attempted a thermite with anhydrous copper sulfate, 30um aluminum, and a little sodium sulfate as flux. It was very difficult to ignite. The exact ratio of reactants is unknown; I started with 10g Al, 10g Na_2SO_4, & 80g $CuSO_4$, but such a mixture wouldn't ignite (it did react to give copper-colored slag when heated with a blowtorch), so I added some more aluminum. I was eventually able to ignite this; it was slower than CuO thermite, but faster than iron oxide thermites. Unfortunately, there wasn't enough heat or flux to produce nice copper globules, but most of the copper was recoverable as particles mixed in with the slag.
>
> It looks more coppery in person; I'd estimate this crap is around half copper, and looks somewhat similar to some native copper I've seen. The image shows the slag after washing in water. The mixture was ignited atop a bed of bentonite granules (cat litter), the blackened remnants of which form most of the rest of the slag. One downside to using sulfates is that the slag did smell slightly of hydrogen sulfide when added to water.
>
> [Edited on 13-11-2015 by MolecularWorld]

Nice thermite, it spared me the trouble of ordering the reagents. The real question is:Could you perhaps separate the copper from the slag by using nitric acid to dissolve the mixture and then performing an electrolysis with sulfuric acid to convert the copper to copper sulfate,then running another electrolysis to recover copper?

[Edited on 13-11-2015 by Agari]

Element Collection Status:
Elements Acquired: 21/91
Latest: Lead (Pb)
Quantity: 12g

PROFILE FIND

MolecularWorld
Hazard to Others
★★★

posted on 12-11-2015 at 17:24

Posts: 110
Registered: 30-10-2015
Member Is Offline

Mood: No Mood

Since copper sulfate was used in the thermite, it would be much simpler to electrolyze the copper sulfate I started with than to make "new" copper sulfate from the copper metal produced by the thermite.

I'm currently soaking most of the slag in sodium hydroxide solution to dissolve everything that isn't copper.

PROFILE FIND

Agari
Banned

posted on 12-11-2015 at 17:32

Posts: 160
Registered: 8-10-2015
Location: The Amine Group
Member Is Offline

Mood: Lowest Oxidation State

> **Quote:** **Originally posted by MolecularWorld**
>
> Since copper sulfate was used in the thermite, it would be much simpler to electrolyze the copper sulfate I started with than to make "new" copper sulfate from the copper metal produced by the thermite.
>
> I'm currently soaking most of the slag in sodium hydroxide solution to dissolve everything that isn't copper.

Simple electrolysis goes against the spirit of the "challenge",a thermite reaction would be a more dramatic way to obtain copper.
Now I know what to order online once I type my entry for J_sum's competition.

Element Collection Status:
Elements Acquired: 21/91
Latest: Lead (Pb)
Quantity: 12g

PROFILE FIND

MolecularWorld
Hazard to Others
★★★

posted on 12-11-2015 at 18:11

Posts: 110
Registered: 30-10-2015
Member Is Offline

Mood: No Mood

In that case, you could certainly make copper sulfate from the copper produced from copper sulfate in order to make copper, but I'm not going to.

If you attempt the copper sulfate thermite, know that the ratios I used weren't ideal. A larger ratio of aluminum and flux to copper sulfate, different fluxes, and a larger batch size, would likely improve it.

PROFILE FIND

MolecularWorld
Hazard to Others
★★★

posted on 13-11-2015 at 12:10

Posts: 110
Registered: 30-10-2015
Member Is Offline

Mood: No Mood

Here's a short clip I salvaged from my attempt at copper sulfate thermite. I've always used sparklers to ignite oxide-based thermites (including copper, iron, manganese, and chromium); this is the first thermite I've made that wouldn't ignite that way. Heating with a butane torch eventually ignited it (to my surprise).

<iframe sandbox width="280" height="280" src="//www.youtube.com/embed/KbihSfKBmhs?rel=0" frameborder="0" allowfullscreen></iframe>

PROFILE FIND

Agari
Banned

posted on 15-11-2015 at 17:11

Posts: 160
Registered: 8-10-2015
Location: The Amine Group
Member Is Offline

Mood: Lowest Oxidation State

> **Quote:** **Originally posted by MolecularWorld**
>
> Here's a short clip I salvaged from my attempt at copper sulfate thermite. I've always used sparklers to ignite oxide-based thermites (including copper, iron, manganese, and chromium); this is the first thermite I've made that wouldn't ignite that way. Heating with a butane torch eventually ignited it (to my surprise).
>
> <iframe sandbox width="280" height="280" src="//www.youtube.com/embed/KbihSfKBmhs?rel=0" frameborder="0" allowfullscreen></iframe>

It is hard to see anything in your video,but it is somewhat recognizable as a thermite reaction. I confused the light source at the beginning with an already-burning mixture,haha.

Element Collection Status:
Elements Acquired: 21/91
Latest: Lead (Pb)
Quantity: 12g

PROFILE FIND

MolecularWorld
Hazard to Others
★★★

posted on 15-11-2015 at 17:21

Posts: 110
Registered: 30-10-2015
Member Is Offline

Mood: No Mood

Yeah, the low quality is due to the lack of light, crappy camera phone, and the fact that I didn't expect it to ignite. I was surprised the camera was still recording, and only later noticed I had caught it on video.

As I said above, the mixture resisted ignition multiple times, instead melting to form a copper-colored slag. It had to be mixed with additional aluminum, and then heated with a butane torch for about 20 seconds, in order to ignite. There are various 'thermite ignition mixtures' used to light stubborn thermites more safely, but as I said, this is the first thermite I've made that couldn't be lit with a sparkler.

Despite the low quality, the video clip serves to illustrate the important characteristics of this thermite: it's difficult to ignite, and it burns slower than a typical cupric oxide thermite (though still quite fast).

In studying the video, I also came to the conclusion that my reagents weren't perfectly anhydrous or well enough mixed.

[Edited on 16-11-2015 by MolecularWorld]

PROFILE FIND

MolecularWorld
Hazard to Others
★★★

posted on 17-11-2015 at 09:41

Posts: 110
Registered: 30-10-2015
Member Is Offline

Mood: No Mood

I found blogfast25's blog (I think), with a page on copper thermite, where he claims to have produced a bead of copper metal from a Cu_2O thermite. Unfortunately, I can't see the photos. I'm currently attempting to produce copper(I) oxide from my copper(II) sulfate via a Benedict's reagent type reaction with sodium carbonate and high-fructose corn syrup, in order to attempt the reaction detailed there.

Though I haven"t given up on a sulfate-based copper thermite; I'll be making another attempt at this by the end of the week.

What is the best way to dry copper(I) oxide? Will it oxidize further if it's heated to dryness in air?

PROFILE FIND

MolecularWorld
Hazard to Others
★★★

posted on 17-11-2015 at 10:52

Posts: 110
Registered: 30-10-2015
Member Is Offline

Mood: No Mood

> **Quote:** **Originally posted by MolecularWorld**
>
> Will it oxidize further if it's heated to dryness in air?

The answer is YES.

PROFILE FIND

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» Energetic Materials